EMC Test Report	
For:	**Displaydata Limited**
Product:	**Electronic Shelf Label**
Model Number (HVIN):	**DD16-3A**
	
Project Engineer:	**Graeme Lawler**
	
Approval Signatory:	**Andy Coombes**

Document Reference:	**4590A FR**

Issue Number:	**Date:**	**Test Report Revisions History:**
1	6th March 2023	Original Report Issued
2	10th July 2023	Updated with Editorial Corrections
3	1st August 2023	Updated with Editorial Corrections
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FCC Registered:	UK2006
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Canada CAB ID:	UK0005

Eurofins E&E Hursley Limited
Trafalgar House, Trafalgar Close
Chandlers Ford, Eastleigh
Hampshire, SO53 4BW
United Kingdom

1871

Phone: +44 (0) 23 8027 1111
e-mail: adminhursley@eurofins.com
www.eurofins.co.uk/hursley

Contents

1.0 OVERVIEW

1.1 Introduction

The equipment under test (EUT) as described within this document was submitted for testing as agreed with the customer.

1.2 Objective

The purpose of the test was to measure and report the EUT against limits and methods of the requested standards as listed in section 2.0 Test Summary.

1.3 Product Modifications

None to sample submitted.

1.4 Conclusion

The EUT met the emission requirements of the tests defined in section 2.0 Test Summary.

This report relates to the sample tested and may not represent the entire population. It is valid only for the product identified, either in part or in full, to the standards and/or tests covered in this document.

1.5 EMC Test Lab Reference

Eurofins E&E Hursley File: 4590A

1.6 Test Deviations

None.

2.0 TEST SUMMARY

2.1 Summary

The EUT, as described and reported within this document, complies with the applied requested sections of the standards listed below.

The EUT met the **emissions** and **immunity** test requirements of the following standards:		
Description	**Referenced Standard**	**Status**
Radiated Emissions	FCC CFR 47 Part 15 (15.109, 15.209, 15.249) ANSI C63.4: 2013 + 4a:2017 ANSI C63.10: 2013 RSS-210 issue 10: 2019 RSS-GEN issue 5:2018 (Amendment 2: February 2021)	Pass
Occupied Bandwidth	FCC CFR 47 Part 15 (15.215) ANSI C63.10: 2013 RSS-GEN issue 5:2018 (Amendment 2: February 2021) AS/NZ 4268 Section 8.3.2	Pass

Note(s):

- The highest internal operating frequency declared by the manufacturer is 928 MHz.

3.0 EQUIPMENT AND TEST DETAILS

3.1 General

Product (EUT):	Electronic Shelf Label		
Model Number (HVIN):	DD16-3A	**Serial Number:**	TA10000030C
Model Name (PMN):	Chroma 16L		
FCC:	VC7-A001566		
IC:	8910A-A001566		
Hardware Version:	EDK705 A011A		
Software Version	See Section 3.4 EUT Test Exerciser		
Sample Build:	Production Sample		
Modulation Type:	GFSK		
Number of Channels:	50		
Operating Frequency:	902.5 MHz to 907.5 MHz		
Channel Spacing:	500 kHz		
EUT Power:	Battery Power		
Customer Test Plan:	Not Applicable		
Alternate Models:	Not Applicable		
EUT Manufacturer:	Displaydata Limited		
Customer Name:	Displaydata Limited		
Customer Address:	Unit 12 Headley Park 10 Headley Road East Woodley Reading Berkshire RG5 4SW United Kingdom		
Test Commissioned By:	Andy Lee		
Date EUT Received:	31st January 2023		
Test Date(s):	31st January to 3rd February 2023		
EMC Measurement Site:	Eurofins E&E Hursley Limited		
	Trafalgar Close, Chandlers Ford, Hampshire, United Kingdom		
Product Category:	IT and Multimedia Electrical Equipment		

3.2 EUT Description

The EUT is an Electronic Shelf Label operating in the 915MHz band for FCC and 866MHz band for EU.

3.3 Support Equipment

Description	Manufacturer	Model	Serial Number
Wireless Link to programme	Displaydata Limited	E2 Dynamic Communicator	ZX00018021

3.4 EUT Test Exerciser

In normal operation the ESL has an extremely low duty cycle. Therefore, to facilitate emissions testing, the ESL is loaded with special RF test software.

By default, when running the RF test software, the ESL is idle, waiting for a test command to be sent from the laptop via the Dynamic Communicator.

Displaydata's 1.3.0 release of RF test software was used during the testing of the ESL

Radiated Emissions testing:

The Dynamic Communicator / Laptop are used to send a command to the ESL which causes the ESL to continuously transmit a continuous (100% duty cycle) modulated carrier, using data rate of 100 kbps.

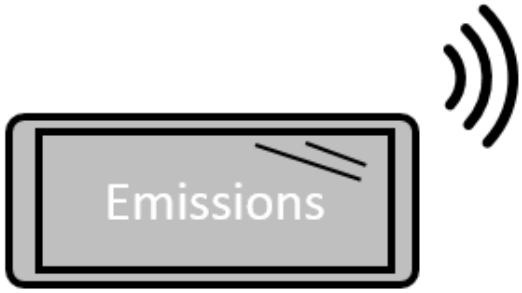
The duration of the continuous modulated transmission is programmable. The duration of transmission is chosen to ensure that the modulated transmission continues for the length of each emissions scan.

Radiated emissions testing was carried out on bottom, middle and top channels, 902.5MHz, 913.5MHz and 927.5 MHz respectively.

Idle Emissions testing:

During Idle Emissions testing of the ESL, running the RF test software, is left in its idle state, there is no active transmission.

3.5 EUT Test Configuration #1



4.0 TEST RESULTS

4.1 Radiated Emissions, Top Channel

4.1.1 Test Parameters

A profile scan was taken using an EMI receiver at a distance of three metres on eight azimuths of the EUT in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1-10GHz)	20/05/2024
250	1	HP	8449B	3008A01077	Pre-amplifier (1.0-26.5GHz)	01/03/2023
516	1	Suhner	Cable N-Type	0	Cable N-Type (for #250)	01/03/2023
762	1	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
821	1	York EMC	CNE	542	Comparison noise emitter	Internal
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.00 (Pluto)	Not required
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	**Below 1GHz**	**Above 1GHz**
Temperature	15.5° Celsius	15.5° Celsius
Relative Humidity	45%	45%
Atmospheric Pressure	1028.8 millibars	1028.8 millibars
Test Date:	31st January to 1st February 2023	1st February 2023
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed for external calibration.

4.1.2 Test Configuration

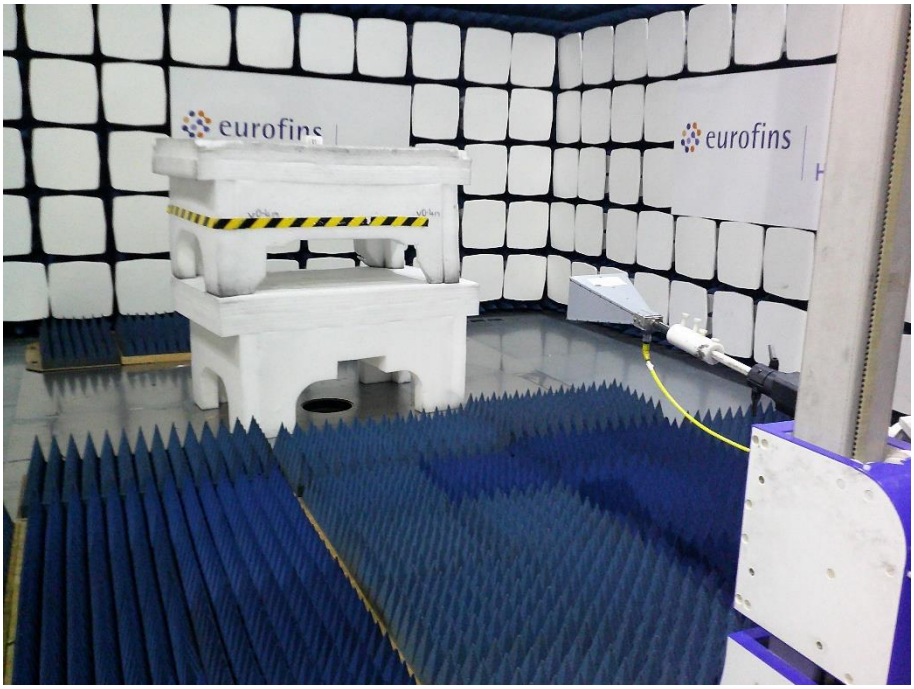
Please refer to EUT Test Configuration #1.

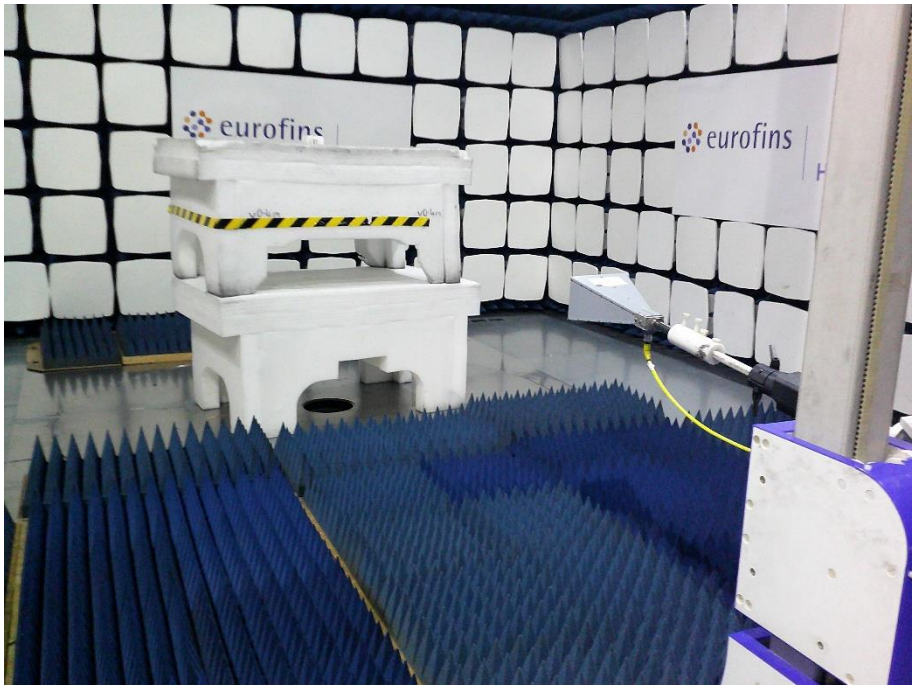
4.1.3 Set-up Photos

Radiated Emissions; Below 1GHz

4.1.4 Set-up Photos (Continued)

Radiated Emissions; Above 1GHz

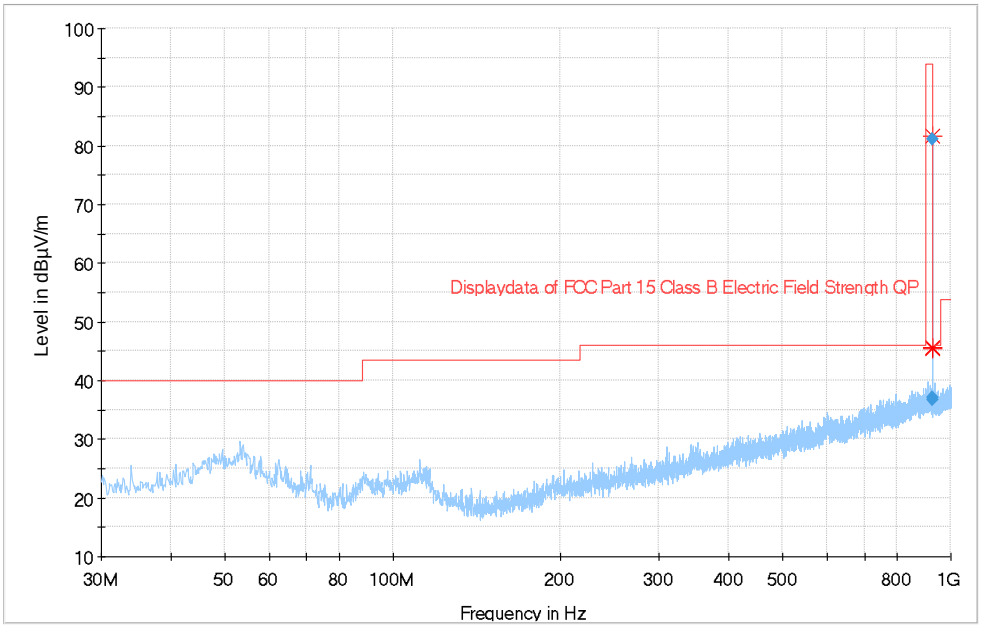




4.1.5 Profile; 30MHz to 1GHz, Top Channel

Maximum peak hold trace with quasi-peak values (◆)
Peak measurements (✳)

30MHz to 1GHz



4.1.6 Data; 30MHz to 1GHz, Top Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
927.500000	81.13	94.00	12.87	V	118.0	279.0	Pass
928.000000	37.10	94.00	56.90	H	100.0	12.0	Pass
928.050000	36.78	46.00	9.22	V	354.0	194.0	Pass

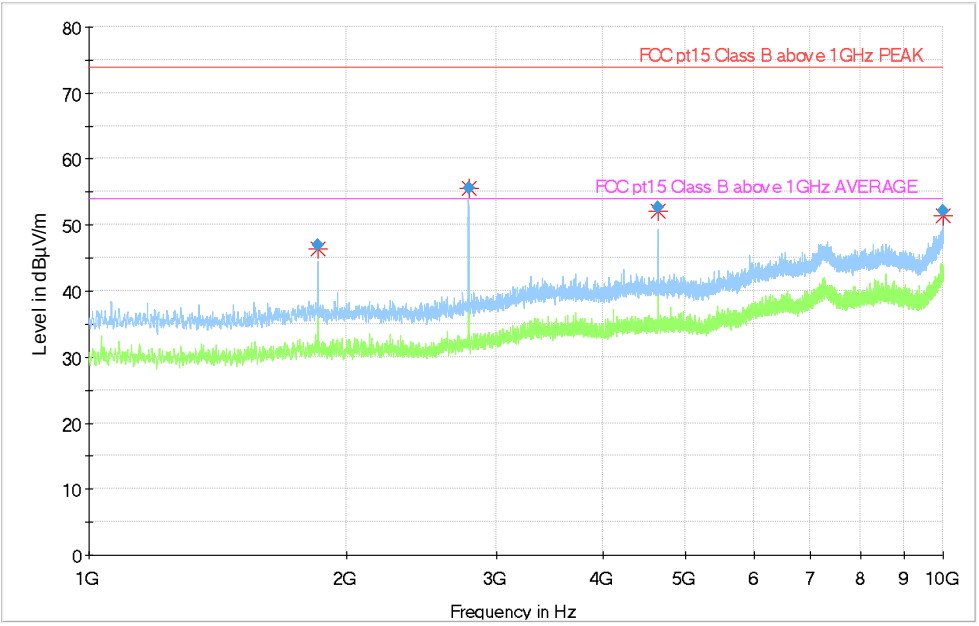
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.1.7 Profile; 1 to 10GHz, Top Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.1.8 Data; 1 to 10GHz, Top Channel

Frequency	Peak	Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
1855.103196	46.97	---	74.00	27.03	100.0	V	206.0	-7.9	Pass
2782.643338	55.61	---	74.00	18.39	344.0	H	258.0	-5.8	Pass
2782.643338	---	35.61	54.00	18.39	344.0	H	258.0	-5.8	Pass
4637.443802	52.72	---	74.00	21.28	100.0	V	201.0	-1.6	Pass
9999.155416	52.07	---	74.00	21.93	216.0	H	89.0	6.8	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

As this EUT relies on pulsed operation, average measurements relating to the fundamental have been determined by calculation in accordance with ANSI c63.10 clause 7.5. First, a peak measurement is performed and a Duty Cycle Correction Factor (DCCF) is added to this peak value.
DCCF (dB) = 20*Log10 (Duty Cycle) = 20Log10 ($Transmitter_{On\ Time}$ /$Transmitter_{On\ Time}$ + $Transmitter_{Off\ Time}$)
DCCF (dB) = 20*Log10 (10mS/10+90) = **-20.00dB**
Emissions not relating to the fundamental have been measured with a CISPR Average detector.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.2 Radiated Emissions, Middle Channel

4.2.1 Test Parameters

A profile scan was taken using an EMI receiver at a distance of three metres on eight azimuths of the EUT in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1-10GHz)	20/05/2024
250	1	HP	8449B	3008A01077	Pre-amplifier (1.0-26.5GHz)	01/03/2023
516	1	Suhner	Cable N-Type	0	Cable N-Type (for #250)	01/03/2023
762	1	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
821	1	York EMC	CNE	542	Comparison noise emitter	Internal
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.00 (Pluto)	Not required
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	**Below 1GHz**	**Above 1GHz**
Temperature	15.5° Celsius	15.5° Celsius
Relative Humidity	45%	45%
Atmospheric Pressure	1028.8 millibars	1028.8 millibars
Test Date:	31st January to 1st February 2023	1st February 2023
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed for external calibration.

4.2.2 Test Configuration

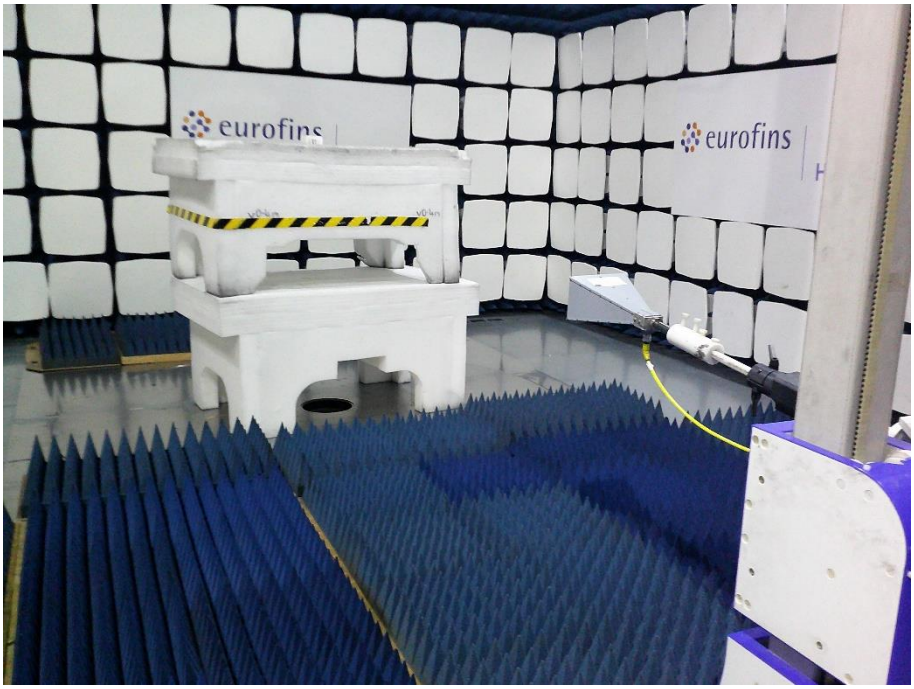
Please refer to EUT Test Configuration #1.

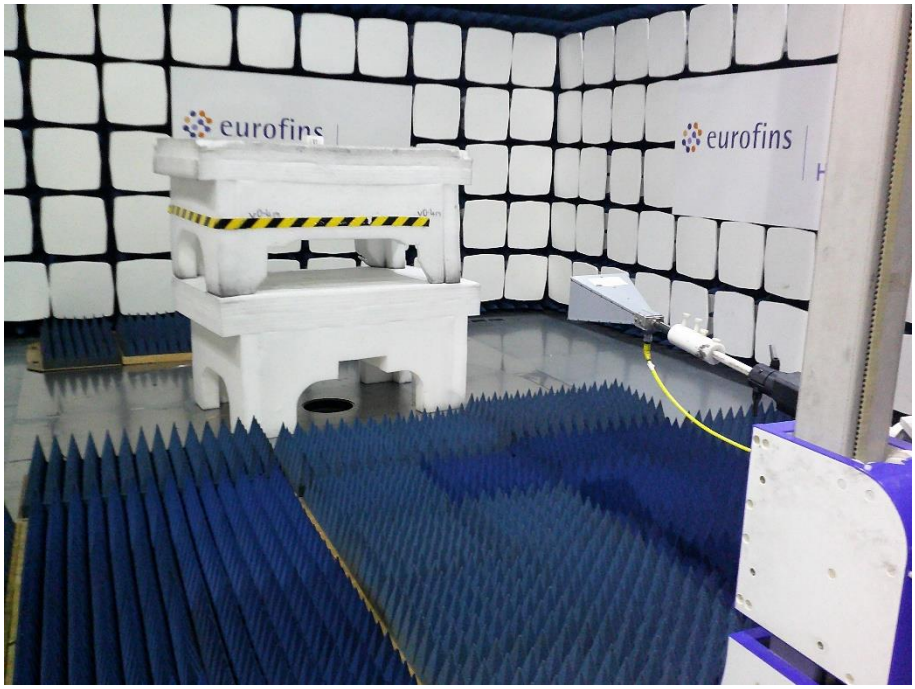
4.2.3 Set-up Photos

Radiated Emissions; Below 1GHz

4.2.4 Set-up Photos (Continued)

Radiated Emissions; Above 1GHz

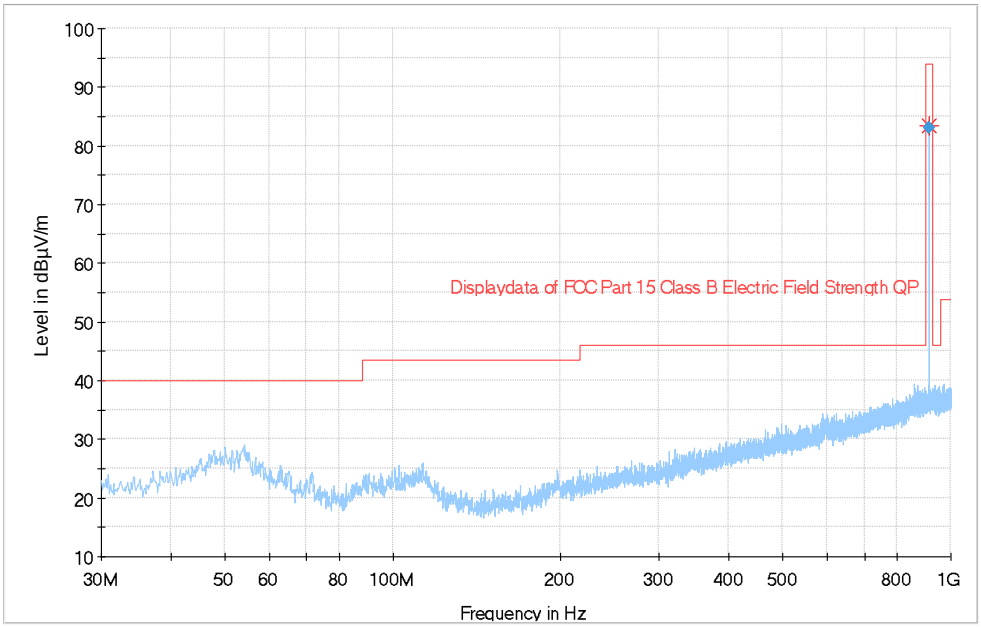




4.2.5 Profile; 30MHz to 1GHz, Middle Channel

Maximum peak hold trace with quasi-peak values (◆)
Peak measurements (✳)

30MHz to 1GHz



4.2.6 Data; 30MHz to 1GHz, Middle Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
913.500000	83.13	94.00	10.87	V	117.0	282.0	Pass

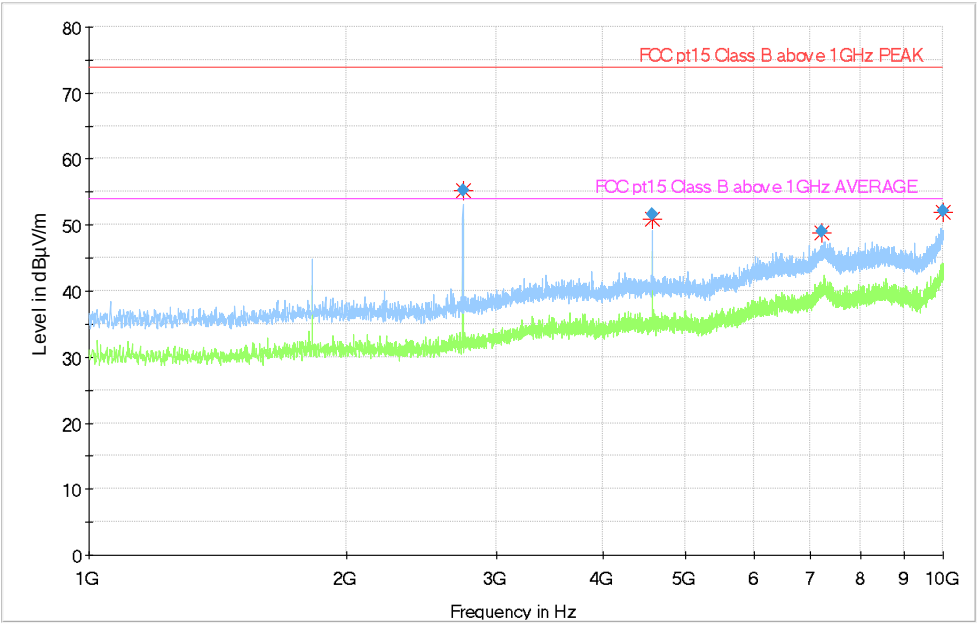
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.2.7 Profile; 1 to 10GHz, Middle Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.2.8 Data; 1 to 10GHz, Middle Channel

Frequency	Peak	Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
2740.597656	55.23	---	74.00	18.77	354.0	H	258.0	-6.0	Pass
2740.597656	---	35.23	54.00	18.77	354.0	H	258.0	-6.0	Pass
4567.289362	51.61	---	74.00	22.39	109.0	V	219.0	-1.5	Pass
7210.526722	48.96	---	74.00	25.04	236.0	V	180.0	4.5	Pass
9999.616203	52.14	---	74.00	21.86	366.0	V	332.0	6.8	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

As this EUT relies on pulsed operation, average measurements relating to the fundamental have been determined by calculation in accordance with ANSI c63.10 clause 7.5. First, a peak measurement is performed and a Duty Cycle Correction Factor (DCCF) is added to this peak value.
DCCF (dB) = 20*Log10 (Duty Cycle) = 20Log10 ($Transmitter_{On\ Time}$ /$Transmitter_{On\ Time}$ + $Transmitter_{Off\ Time}$)
DCCF (dB) = 20*Log10 (10mS/10+90) = **-20.00**
Emissions not relating to the fundamental have been measured with a CISPR Average detector.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.3 Radiated Emissions, Bottom Channel

4.3.1 Test Parameters

A profile scan was taken using an EMI receiver at a distance of three metres on eight azimuths of the EUT in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

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516	1	Suhner	Cable N-Type	0	Cable N-Type (for #250)	01/03/2023
762	1	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
821	1	York EMC	CNE	542	Comparison noise emitter	Internal
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.00 (Pluto)	Not required
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	**Below 1GHz**	**Above 1GHz**
Temperature	15.5° Celsius	15.5° Celsius
Relative Humidity	45%	45%
Atmospheric Pressure	1028.8 millibars	1028.8 millibars
Test Date:	31st January to 1st February 2023	1st February 2023
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed for external calibration.

4.3.2 Test Configuration

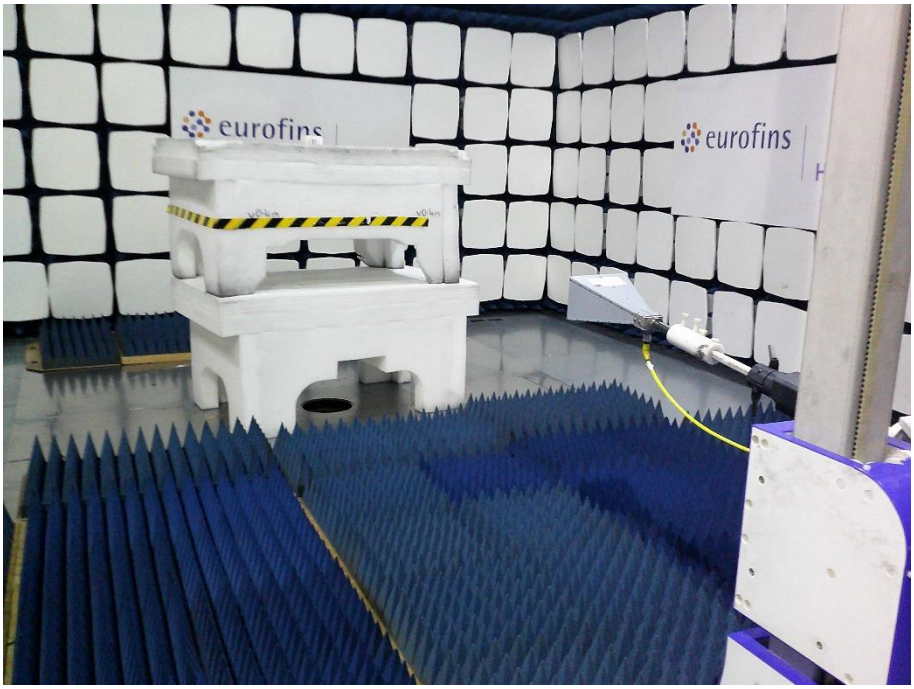
Please refer to EUT Test Configuration #1.

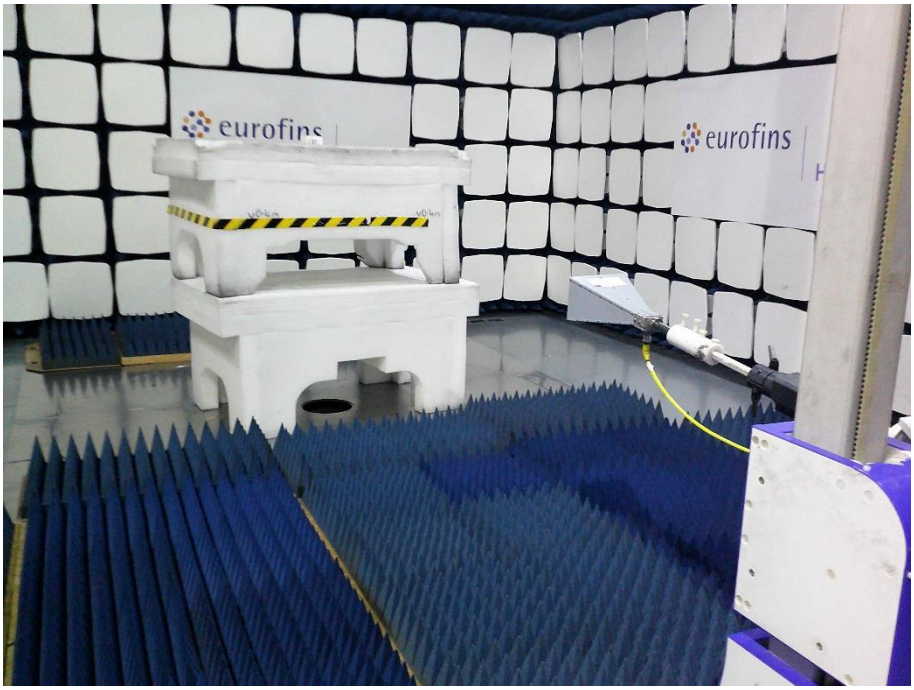
4.3.3 Set-up Photos

Radiated Emissions; Below 1GHz

4.3.4 Set-up Photos (Continued)

Radiated Emissions; Above 1GHz

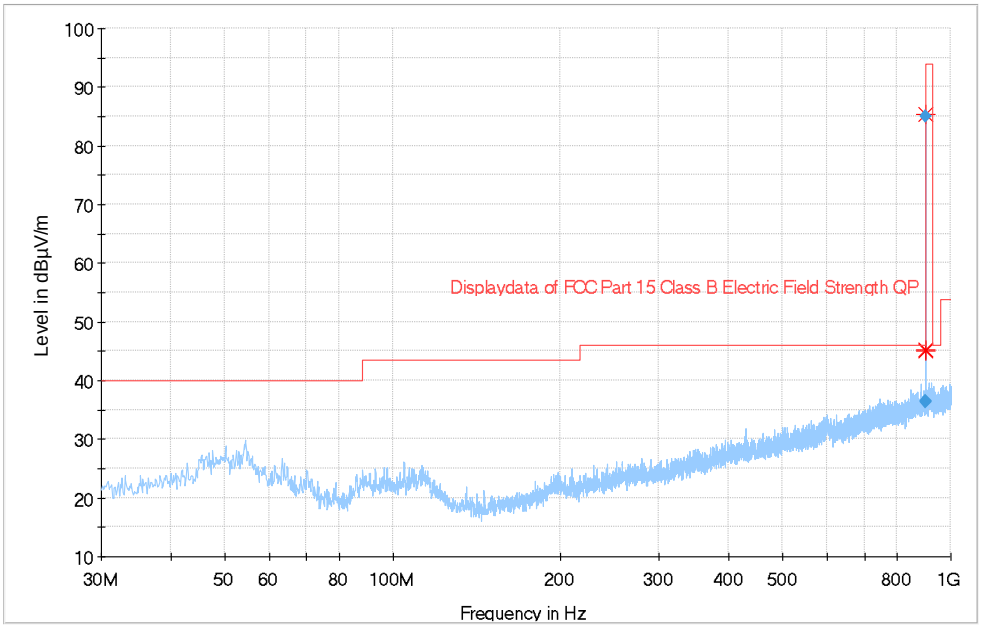




4.3.5 Profile; 30MHz to 1GHz, Bottom Channel

Maximum peak hold trace with quasi-peak values (◆)
Peak measurements (✳)

30MHz to 1GHz



4.3.6 Data; 30MHz to 1GHz, Bottom Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.249 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
901.950000	36.34	46.00	9.66	H	396.0	241.0	Pass
902.000000	36.56	94.00	57.44	H	179.0	213.0	Pass
902.500000	84.98	94.00	9.02	V	118.0	76.0	Pass

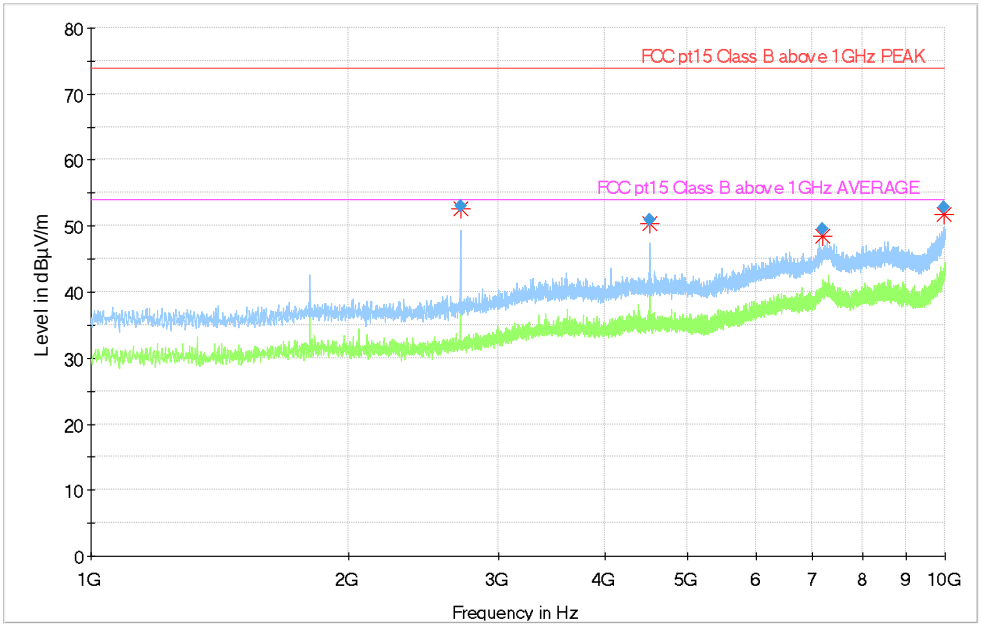
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.3.7 Profile; 1 to 10GHz, Bottom Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 10GHz



4.3.8 Data; 1 to 10GHz, Bottom Channel

Frequency	Peak	CISPR Average	FCC 15.249 Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
2707.462301	52.95	---	74.00	21.05	118.0	H	276.0	-6.2	Pass
4512.701224	50.96	---	74.00	23.04	100.0	V	204.0	-1.5	Pass
7189.532259	49.61	---	74.00	24.39	275.0	H	298.0	4.3	Pass
9962.889516	52.82	---	74.00	21.18	156.0	H	211.0	6.5	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.249 limits and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.

As this EUT relies on pulsed operation, average measurements relating to the fundamental have been determined by calculation in accordance with ANSI c63.10 clause 7.5. First, a peak measurement is performed and a Duty Cycle Correction Factor (DCCF) is added to this peak value.
DCCF (dB) = 20*Log10 (Duty Cycle) = 20Log10 ($Transmitter_{On\ Time}$ /$Transmitter_{On\ Time}$ + $Transmitter_{Off\ Time}$)
DCCF (dB) = 20*Log10 (10mS/10+90) = **-20.00**
Emissions not relating to the fundamental have been measured with a CISPR Average detector.

*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.4 Radiated Emissions, Idle Channel

4.4.1 Test Parameters

A profile scan was taken using an EMI receiver at a distance of three metres on eight azimuths of the EUT in both the vertical and horizontal polarisation of the field in a semi-anechoic chamber.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres using the specified detector in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The worst-case results are reported below.

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
073	3	Schwarzbeck	BBHA9120B	237	Horn Antenna (1-10GHz)	20/05/2024
250	1	HP	8449B	3008A01077	Pre-amplifier (1.0-26.5GHz)	01/03/2023
516	1	Suhner	Cable N-Type	0	Cable N-Type (for #250)	01/03/2023
762	1	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
821	1	York EMC	CNE	542	Comparison noise emitter	Internal
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.00 (Pluto)	Not required
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023
Test Equipment Software						
#ID	CP	Manufacturer	Type		Description	Calibration Due Date
856	0	Rohde & Schwarz	Software	0	EMC32 v11.30.0	Not required

Environmental Test Conditions		
Frequency	**Below 1GHz**	**Above 1GHz**
Temperature	15.5° Celsius	15.5° Celsius
Relative Humidity	45%	45%
Atmospheric Pressure	1028.8 millibars	1028.8 millibars
Test Date:	31st January to 1st February 2023	1st February 2023
Test Engineer:	Graeme Lawler	Graeme Lawler

Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed for external calibration.

4.4.2 Test Configuration

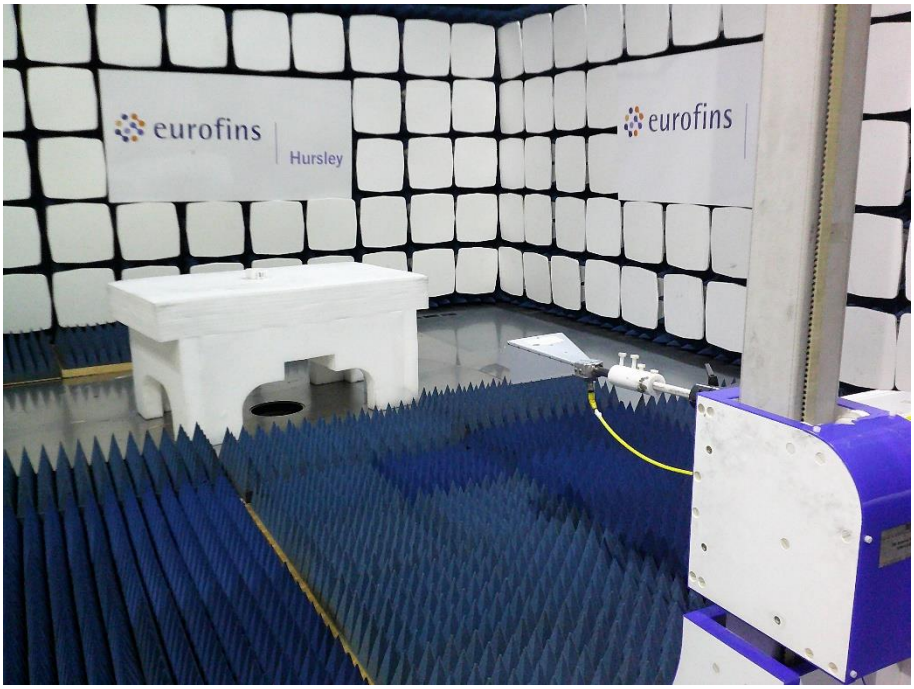
Please refer to EUT Test Configuration #1.

4.4.3 Set-up Photos

Radiated Emissions; Below 1GHz

4.4.4 Set-up Photos (Continued)

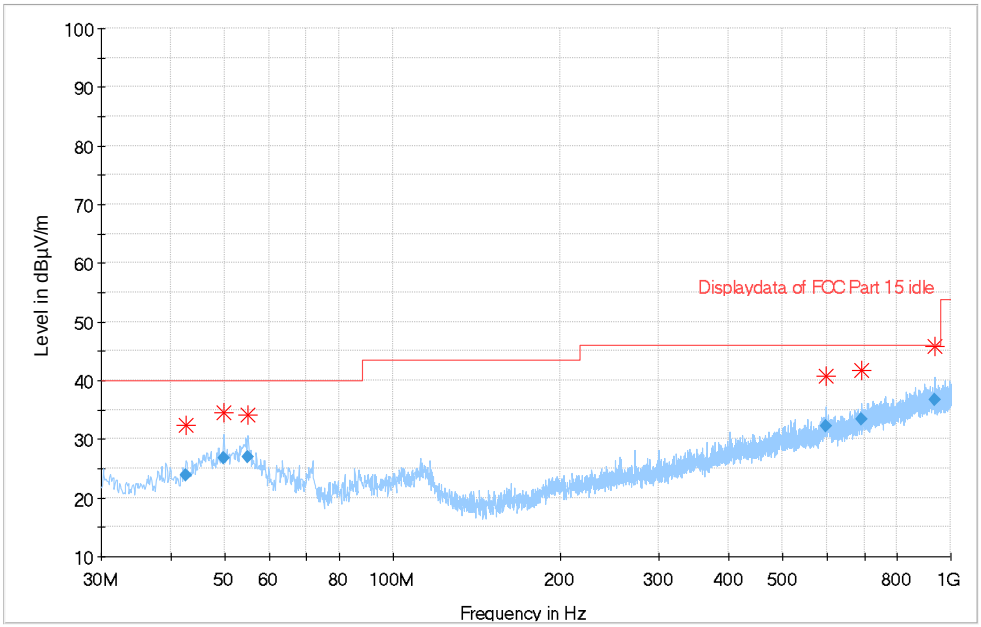
Radiated Emissions; Above 1GHz



4.4.5 Profile; 30MHz to 1GHz, Idle Channel

Maximum peak hold trace with quasi-peak values (◆)
Peak measurements (✳)

30MHz to 1GHz



4.4.6 Data; 30MHz to 1GHz, Idle Channel

Emission Frequency	Measured Quasi-Peak Value	FCC 15.109 Specified Quasi-Peak Limit	Pass Margin	Antenna Polarisation	Antenna Height	Turntable Azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
42.572500	23.89	40.00	16.11	H	185.0	200.0	Pass
49.740000	26.73	40.00	13.27	H	177.0	5.0	Pass
55.027500	26.92	40.00	13.08	H	138.0	60.0	Pass
597.875000	32.30	46.00	13.70	H	177.0	197.0	Pass
690.250000	33.31	46.00	12.69	H	118.0	77.0	Pass
934.500000	36.76	46.00	9.24	V	217.0	284.0	Pass

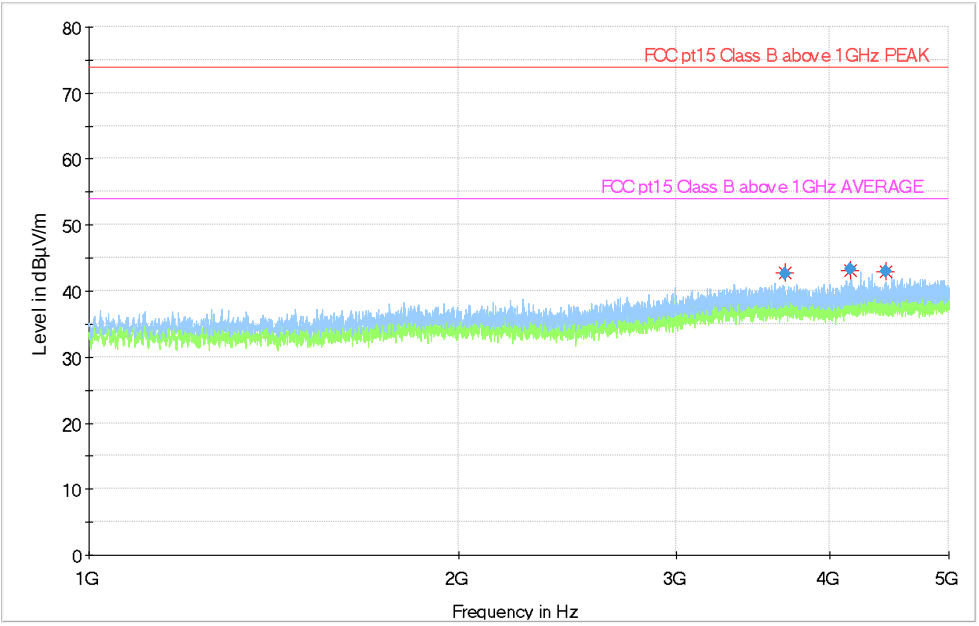
V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.109 Class B Limit and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: Path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.4.7 Profile; 1 to 5GHz, Idle Channel

Maximum hold trace with peak values (◆)
Peak measurements (✳)
Average measurements (◆)

1 to 5GHz



4.4.8 Data; 1 to 5GHz, Idle Channel

Frequency	Peak	CISPR Average	FCC 15.109 Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/m	dB	cm	H/V	Deg	dB/m	Status
3677.908828	42.67	---	74.00	31.33	118.0	H	290.0	-2.7	Pass
4162.078594	43.36	---	74.00	30.64	168.0	H	279.0	-1.7	Pass
4445.214028	42.89	---	74.00	31.11	186.0	V	97.0	-1.5	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC 15.109 Class B Limit and take into account the correction factor*. Measurements made according to the CISPR test standard and Eurofins Hursley test procedure RAD-01.
*Correction factor (dB) = cable and antenna losses as summed positive values (dB) – pre-amp gain where applicable (dB).
The recorded measured value (dB) = measured receiver value (dB) + correction factor (dB).
Note: path losses are factored into the limit value, and given by the test standard. Chamber calibration data contributes to the measurement uncertainty figure.

4.5 Occupied Bandwidth; ISED

4.5.1 Test Parameters

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
652	1	TFA	weather station	Jupiter	Neptune Weather Station	02/11/2023
750	1	Global	CISPR16	1	11 x 7 x 6.2m, chamber	22/12/2023
762	3	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023

Environmental Test Conditions	
Temperature	15.5° Celsius
Relative Humidity	45%
Atmospheric Pressure	1028.8 millibars
Test Date:	31st January to 1st February 2023
Test Engineer:	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.5.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.5.3 Occupied Bandwidth; ISED

RSS GEN Clause 6.7

The output from the measuring antenna was fed into the input of the ESW44 spectrum analyser/receiver. The bandwidth of the transmitter was measured with an ESW44 analyser set to 99% Occupied Bandwidth with a sampling detector on max hold. The resolution bandwidth, span and video bandwidth are indicated on the occupied bandwidth plot (modulated) included with this report.

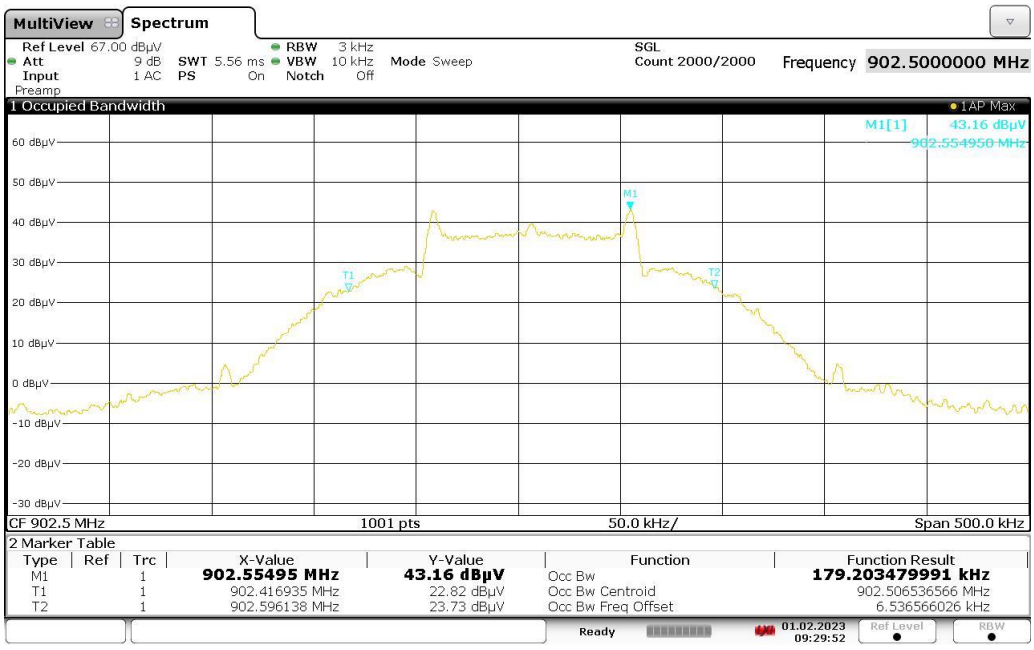
In TX mode with a 100kbps data rate the bandwidth of the modulated transmitter signal was measured.

4.5.4 Set-up Photos

Occupied Bandwidth

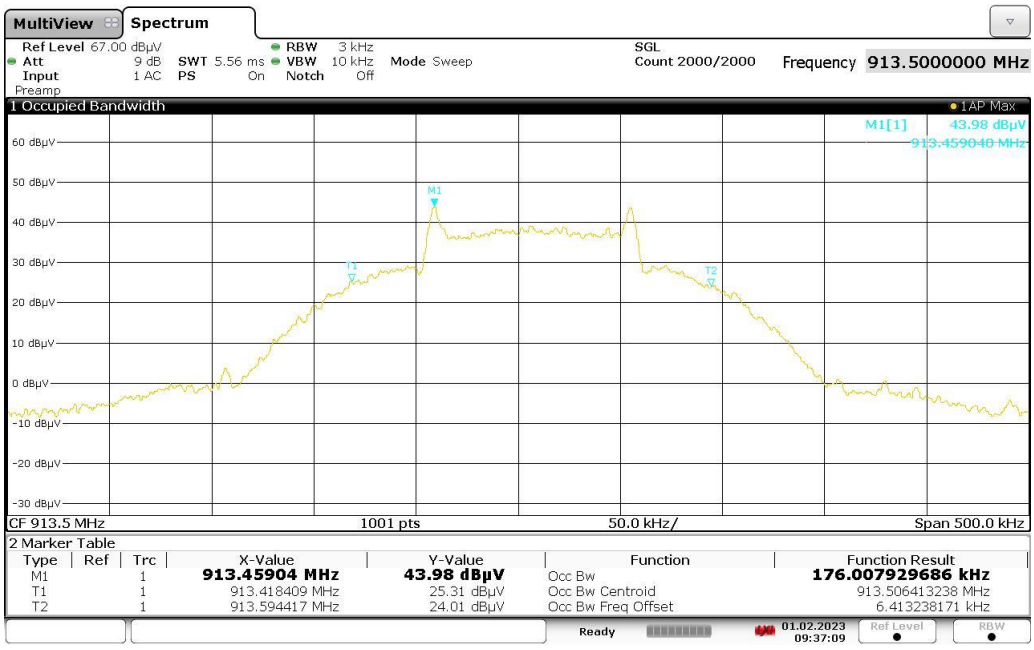
4.5.5 Profiles; ISED

Top channel
179.203 kHz



09:29:52 01.02.2023

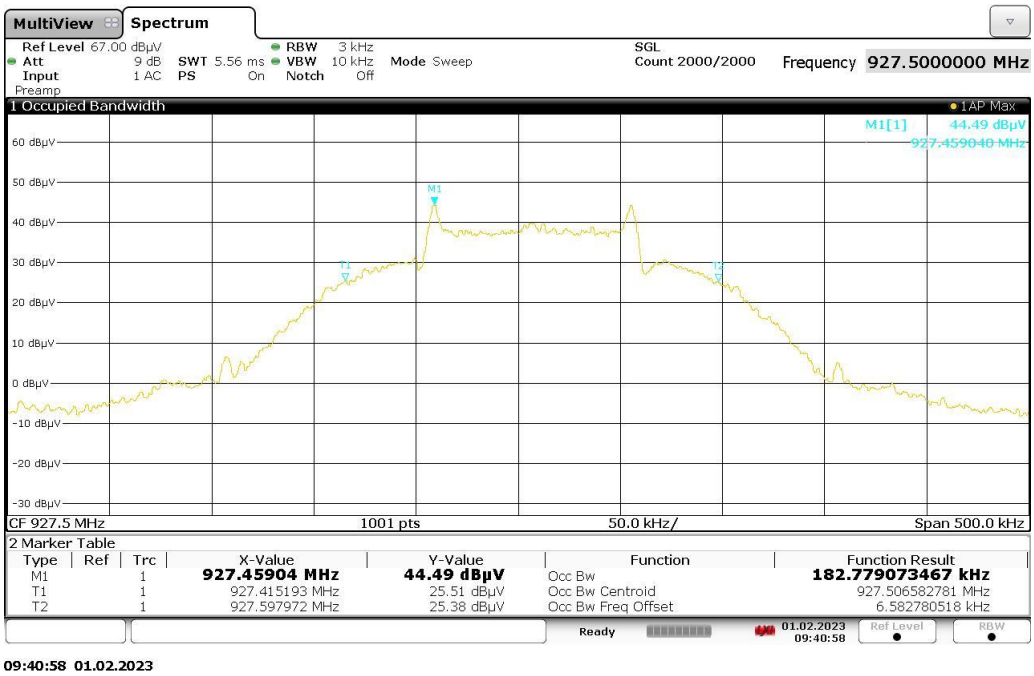
Middle channel
176.008 kHz



09:37:10 01.02.2023

4.5.6 Profiles; ISED (Continued)

Bottom channel
182.779 kHz



4.6 20 dB Bandwidth; FCC

4.6.1 Test Parameters

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
652	1	TFA	weather station	Jupiter	Neptune Weather Station	02/11/2023
750	1	Global	CISPR16	1	11 x 7 x 6.2m, chamber	22/12/2023
762	3	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023

Environmental Test Conditions	
Temperature	15.5° Celsius
Relative Humidity	45%
Atmospheric Pressure	1028.8 millibars
Test Date:	31st January to 1st February 2023
Test Engineer:	Graeme Lawler

Note: “Calibration due date” means the instrument is certified within UKAS or traceable calibration certificate. “Internal” means the instrument is calibrated using Eurofins Hursley procedures. “Not required” means the asset does not require calibration. “CP” is the interval period [year] prescribed for external calibration.

4.6.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.6.3 20 dB Bandwidth; FCC

FCC Clause 15.215

The output from the measuring antenna was fed into the input of the ESW 44 spectrum analyser/receiver. The 20 dB bandwidth of the transmitter was measured with an ESW 44 analyser trace with a sampling detector on max hold. Markers were set either side of the trace 20dB down from the peak. The 20 dB Bandwidth is the difference in frequency between these two markers. The resolution bandwidth, span and video bandwidth are indicated on the 20dB bandwidth plot (modulated) included with this report.

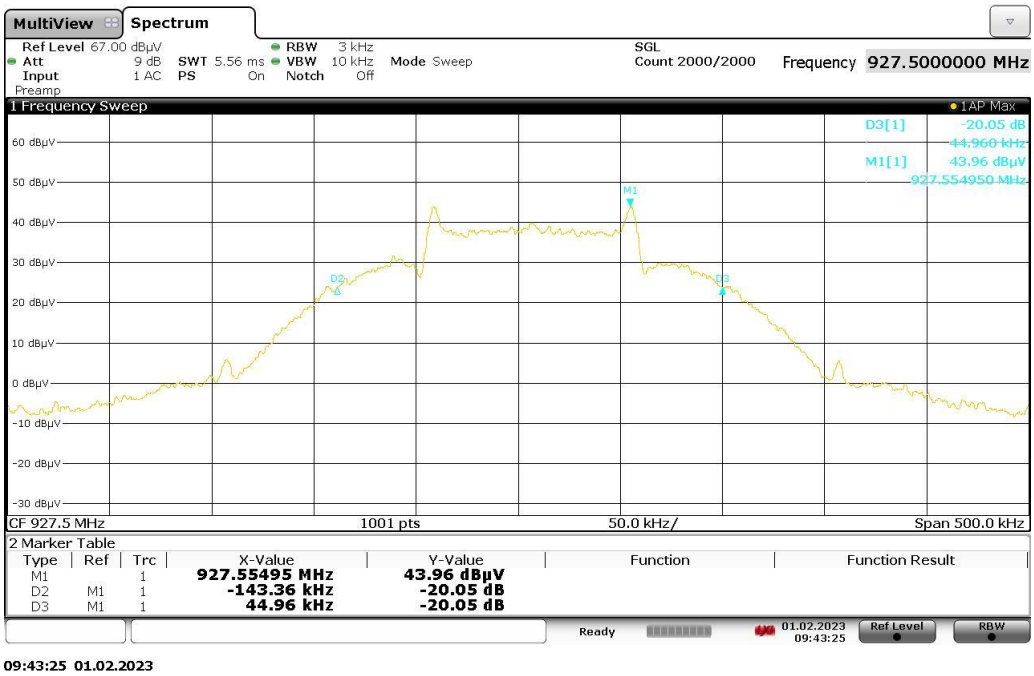
In TX mode with a 100kbps data rate the bandwidth of the modulated transmitter signal was measured.

4.6.4 Set-up Photos

20 dB Bandwidth

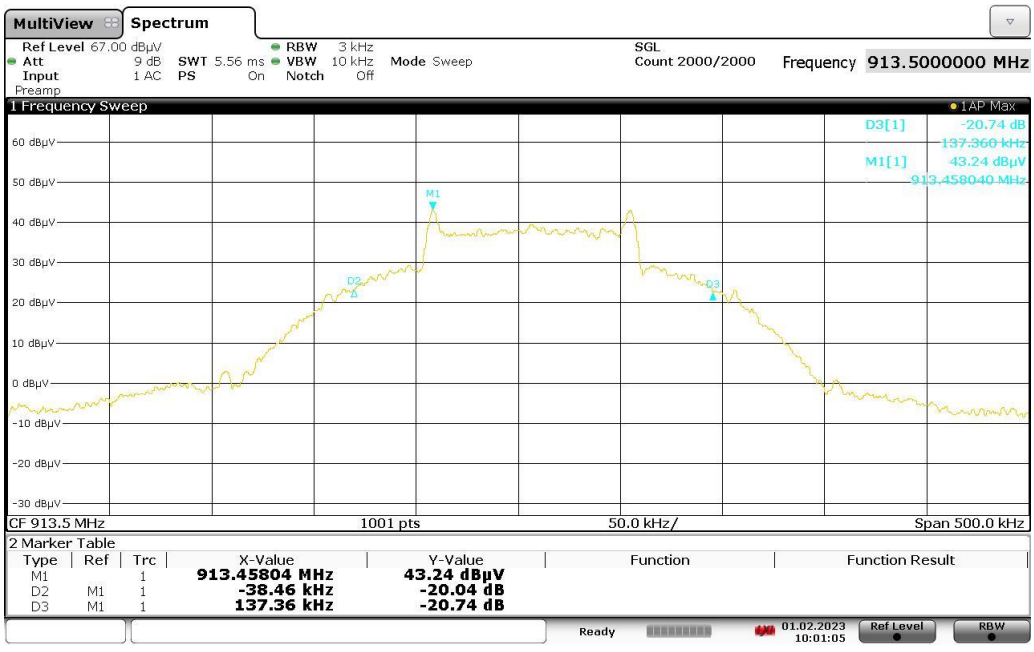
4.6.5 Profiles; FCC

Top channel
188.320 kHz



09:43:25 01.02.2023

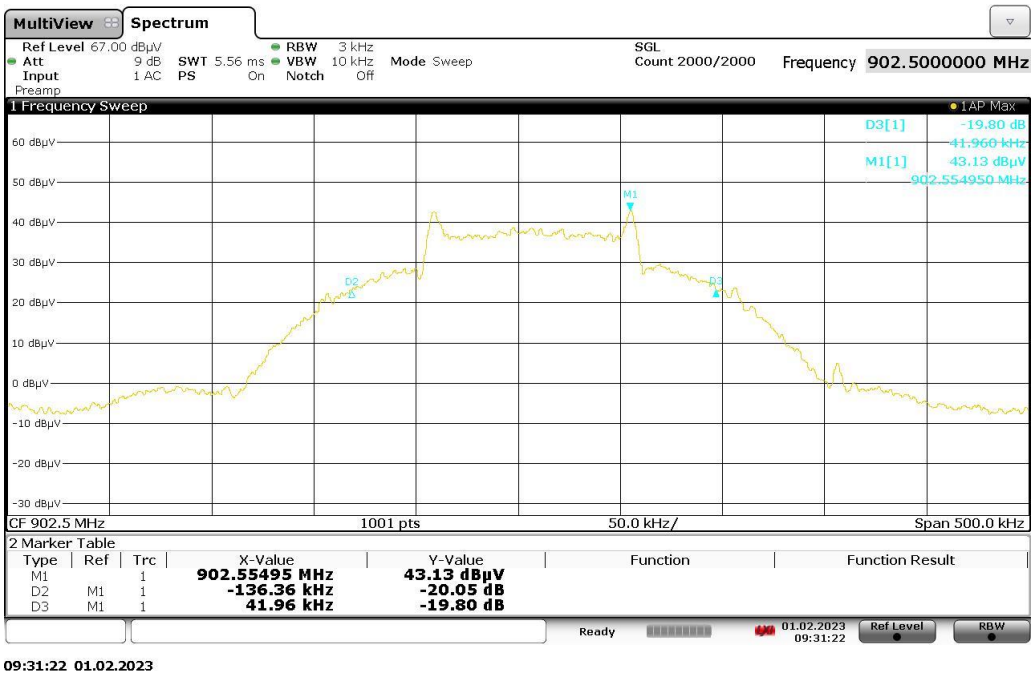
Middle channel
175.820 kHz



10:01:05 01.02.2023

4.6.6 Profiles; FCC (Continued)

Bottom channel
178.320 kHz



09:31:22 01.02.2023

4.7 Occupied Bandwidth; As/Nz

4.7.1 Test Parameters

Test Equipment						
#ID	CP	Manufacturer	Type	Serial Number	Description	Calibration Due Date
652	1	TFA	weather station	Jupiter	Neptune Weather Station	02/11/2023
750	1	Global	CISPR16	1	11 x 7 x 6.2m, chamber	22/12/2023
762	3	Schwarzbeck	VULB9162	129	30-7000MHz	04/03/2024
778	1	IntelliConnect	Cable N-Type	I5071	Cable N-Type	21/11/2023
788	1	Rohde & Schwarz	ESW 44	101799	EMI test receiver (44GHz)	09/08/2023
877	1	Huber & Suhner	SUCOTEST_18A	602608/18A	ST_18A/Nm/Nm/3m	19/04/2023

Environmental Test Conditions	
Temperature	15.5° Celsius
Relative Humidity	45%
Atmospheric Pressure	1028.8 millibars
Test Date:	31st January to 1st February 2023
Test Engineer:	Graeme Lawler

Note: "Calibration due date" means the instrument is certified within UKAS or traceable calibration certificate. "Internal" means the instrument is calibrated using Eurofins Hursley procedures. "Not required" means the asset does not require calibration. "CP" is the interval period [year] prescribed for external calibration.

4.7.2 Test Configuration

Please refer to EUT Test Configuration #1.

4.7.3 Occupied Bandwidth; As/Nz

AS/NZ 4268 Section 8.3.2

The output from the measuring antenna was fed into the input of the ESW 44 spectrum analyser/receiver. The bandwidth of the transmitter was measured with an ESW 44 analyser set to 99% Occupied Bandwidth with a sampling detector on max hold. The resolution bandwidth, span and video bandwidth are indicated on the occupied bandwidth plot (modulated) included with this report.

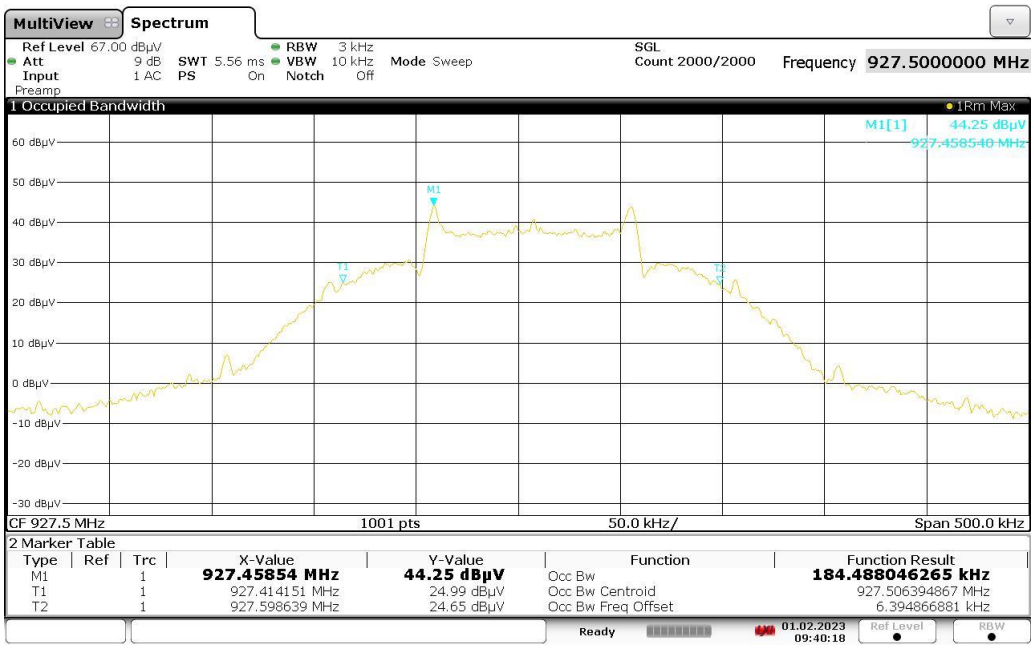
In TX mode with a 100kbps data rate the bandwidth of the modulated transmitter signal was measured.

4.7.4 Set-up Photos

Occupied Bandwidth

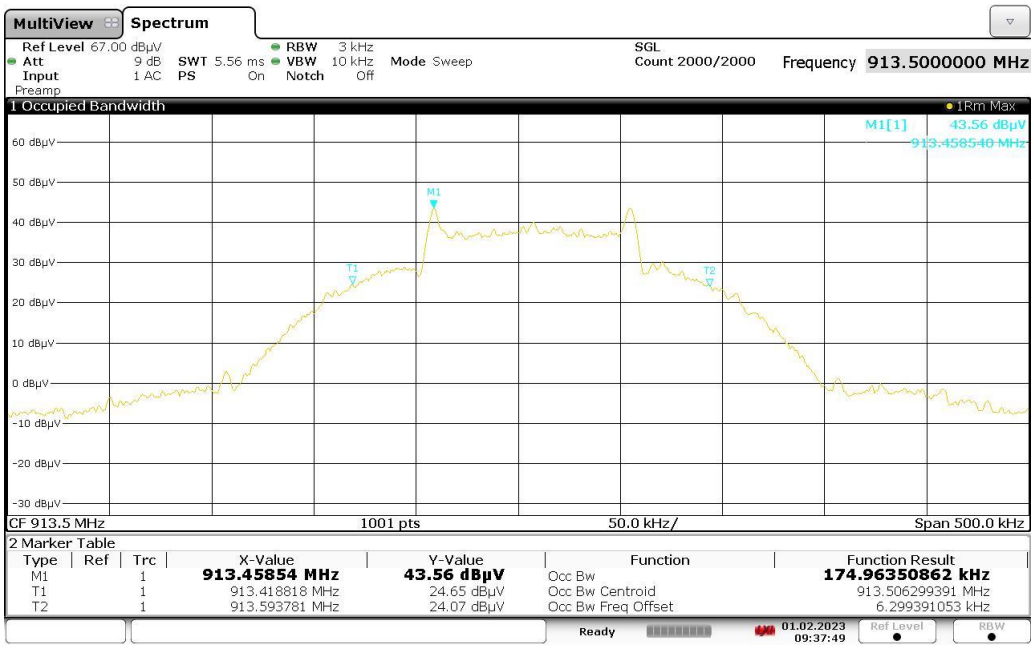
4.7.5 Profiles; As/Nz

Top channel
184.448 kHz



09:40:19 01.02.2023

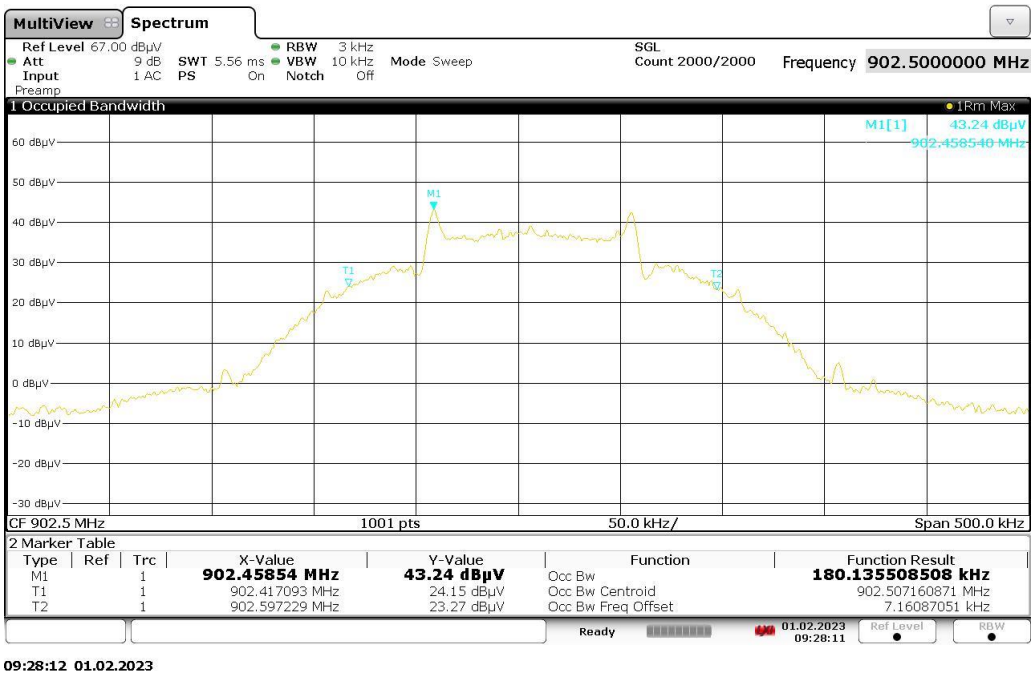
Middle channel
174.964 kHz



09:37:50 01.02.2023

4.7.6 Profiles; As/Nz (Continued)

Bottom channel
180.136 kHz



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5.0 MEASUREMENT UNCERTAINTIES

Emissions tests

For all emissions tests, measurement uncertainties have been calculated in line with the requirements of CISPR 16-4-2 to give a confidence level of greater than 95%. In all cases the laboratories calculated uncertainty values (known as Ulab) are equal to or are less than the expected uncertainty values contained in CISPR 16-4-2 (known as Ucispr). Below is a list of the laboratories calculated measurement uncertainties:

Conducted emissions:

Via AMN/LISN:	±3.27dB (9kHz – 150kHz), ±3.27dB (150kHz – 30MHz)
Via AAN/ISN:	±5.00dB (150kHz – 30MHz)
Via CVP:	±3.47dB (150kHz – 30MHz)
Via CP:	±2.69dB (150kHz – 30MHz)
Via 100 Ω:	±2.68dB (150kHz – 30MHz)
Clicks:	±2.83dB (150kHz – 30MHz)
Harmonics:	±1.42% (100Hz – 2kHz)
Flicker:	±1.76% (worst case for all parameters)

Radiated emissions:

H-Field:	±2.84dB (9kHz – 3MHz), ±2.92dB (3MHz – 30MHz)
D = 3.0 m (Horizontal):	±3.91dB (30MHz – 1GHz SAC), ±3.82dB (30MHz – 1GHz FAC)
D = 3.0 m (Vertical):	±5.22dB (30MHz – 1GHz SAC), ±3.82dB (30MHz – 1GHz FAC)
D = 3.0 m:	±5.13dB (1GHz – 6GHz SAC), ±5.15dB (1GHz – 10GHz SAC), ±3.64dB (10GHz – 18GHz SAC), ±3.10dB (18GHz – 40GHz SAC). ±3.05dB (1GHz – 6GHz FAC)

Radiated spurious emissions (RSE):

±1.71dB (30MHz – 1GHz), ±1.81dB (1 – 12.75GHz), ±2.07dB (12.75 – 18GHz)

Immunity tests

For IEC 61000-4-2, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-8, IEC 61000-4-9, IEC 61000-4-11 tests, the following applies:

Measurement uncertainty has been calculated or calibrated for the various required parameters to provide a confidence level of 95% (k=2). These parameters have been compared to the basic standard tolerance requirements for each of the various parameters.
In all cases the calculated or calibrated uncertainty meets the basic standard requirements.

For IEC 61000-4-3, IEC 61000-4-6 tests, the following applies:

Measurement uncertainty has been calculated to provide a confidence level of 95%, or k=2, but this has not been applied to the applied test level, therefore the applied test level has an uncertainty of ±50%. This is in accordance with CENELEC and other international guidance.

In the case of Maritime equipment tested to EN/IEC 60945, there is a specific requirement that the applied test level be increased by the calculated measurement uncertainty. This is done by applying a coverage factor of k=1.64, which provides a 95% confidence that the applied test level has been achieved.

Test Results - Decision Rules

As the decision is generally inherent in the standard for Commercial EMC a simple acceptance rule can be applied. The following statement will be added to EMC quotes and reports. "The Decision Rule is applied on the basis of CISPR16-4-2 and/or EN61000-4-x (TR61000-1-6) These standards provide guidance on how to calculate and apply measurement uncertainty whilst providing maximum uncertainties allowance. Due consideration will also be given to JCGM 106:2012, ILAC-G8:09/2019 and LAB 48. This laboratory has demonstrated by calibrating its equipment and facilities, and calculating its own uncertainties, that it complies with the above requirements and therefore no allowance of uncertainties has been given to the tolerances." Where a result is considered marginal in respect of its proximity to the limit line, for example, the customer would be made aware of situation so that they can make an informed decision on how to proceed.

Published 02/08/2022

End of Document